Using multiple reanalyses to help diagnose the long wave clear-sky difference between models and observations.

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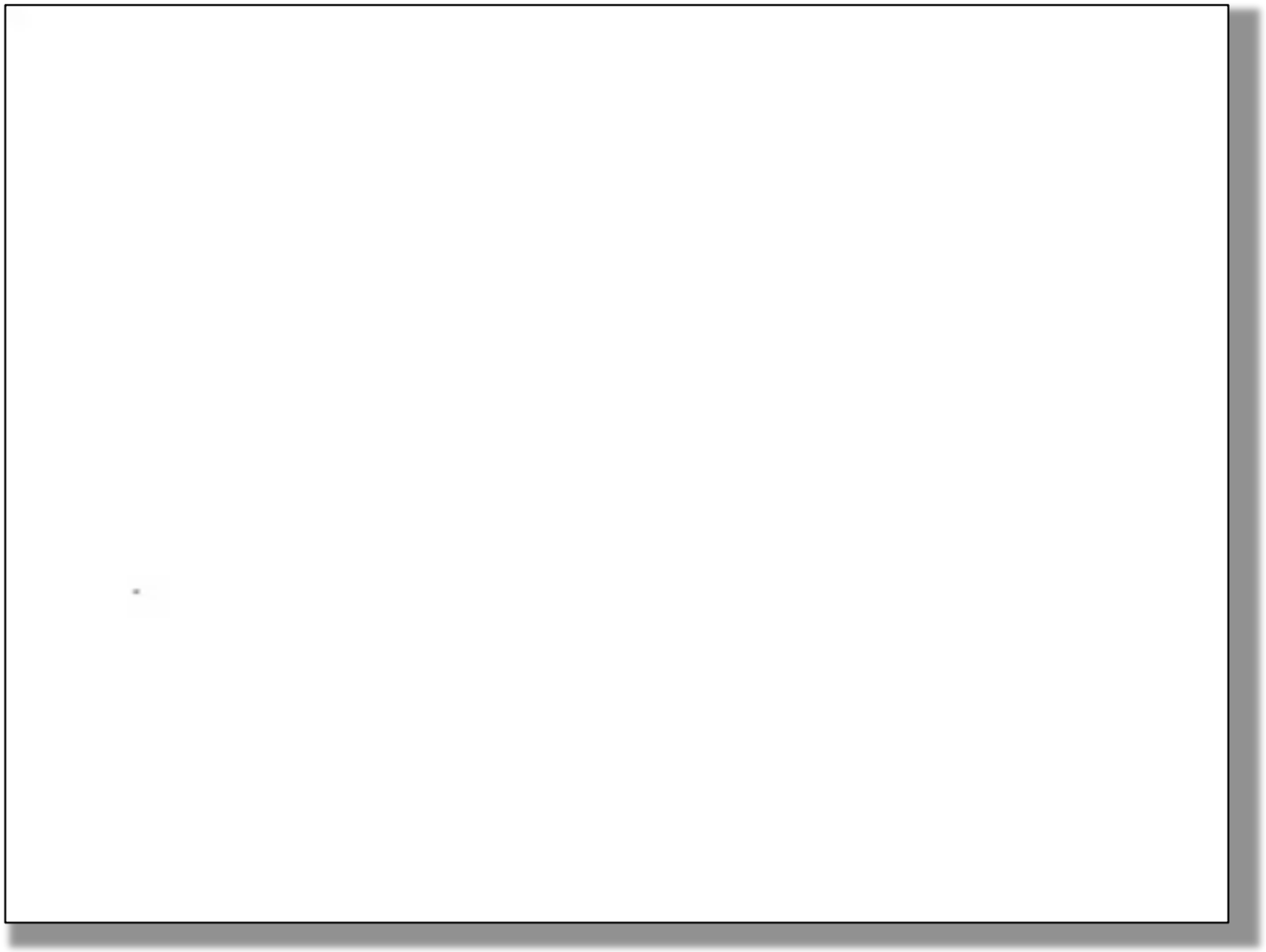
Review of Method 1 and 2

- Well know difference between model LW Clear-sky flux and observed
- 1992 papers:
  - Potter, Slingo (Dame Julia) , Morcrette, and Corsetti: JGR 1992
  - Cess, Potter, Gates, Morcrette, and Corsetti JGR 1992
- Method I and II
  - Method I – only calculate clear sky when clouds are absent
  - Method II – calculate the clear-sky every radiation calculation

Method I and II



We proposed an alternative clear-sky calculation but it never caught on.

- Needed a way to validate CRF
- Devised a hybrid method to account for LW clear-sky bias.
- We called this Method III
  - If a cloud is absent at one or more times within a given day and grid point then produce a diurnally average clear sky flux

This was closer to the ERBE processing but there are still missing data

Cess et. al. 1992

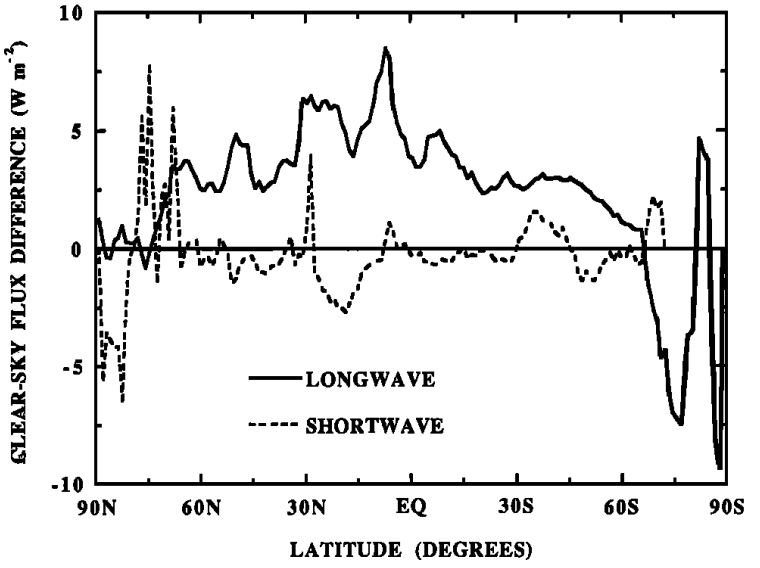
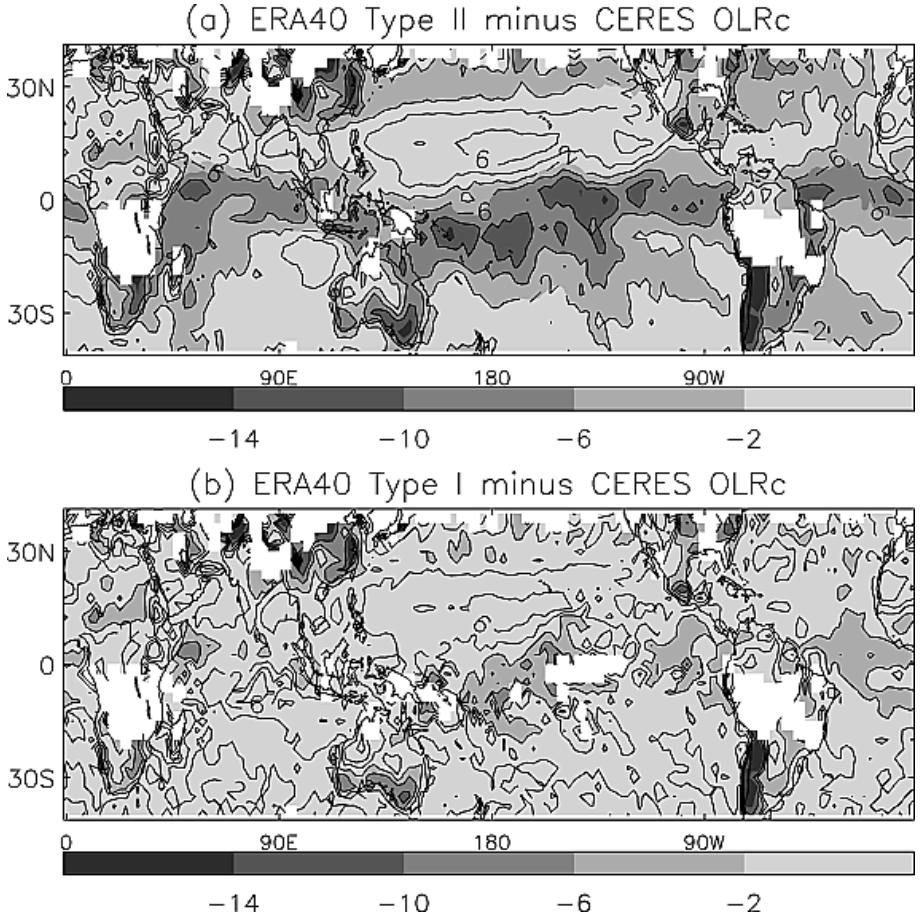


Fig. 1. Zonal mean Method III minus Method II clear-sky flux differences for July.

Other papers followed Method I used to determine type of error

- More recently:
  - Allan, Ringer, Pamment, and Slingo (Tony) 2004
  - Used ERA40 Method II OLR clear-sky

Simulation of the Earth's radiation budget by the European Centre for Medium-Range Weather Forecasts 40-year reanalysis (ERA40)



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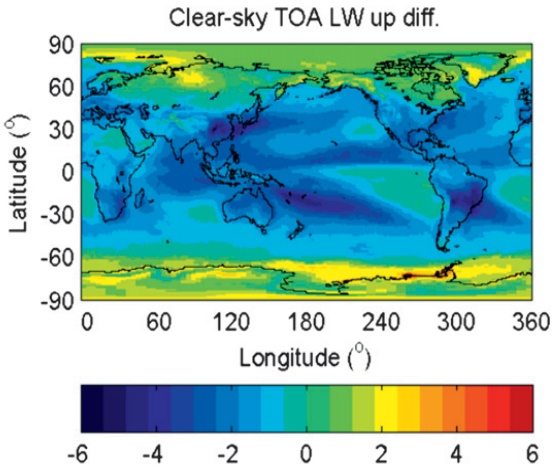
Volume 109, Issue D18, D18107, 18 SEP 2004 DOI: 10.1029/2004JD004816
http://onlinelibrary.wiley.com/doi/10.1029/2004JD004816/full#jgrd11452-fig-0006

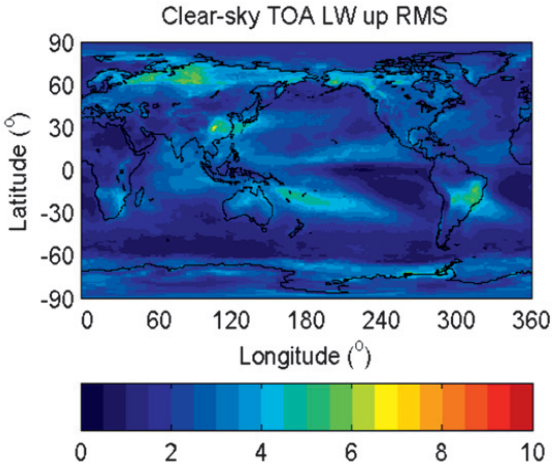
Fast forward to the present now CERES clear-sky be determined using Method II

Kato et al. calculated a "method 2" LW Clear Sky flux using the Fu-Liou radiative transfer model.

Modeled clear-sky minus CERES



RMS difference



Does this imply that the difference between model and CERES is actually model bias and not sampling errors?

Getting data

- Now… for a commercial
- New Earth System Grid Federation projects;
  - obs4MIPs
    - CERES, AIRS, MODIS, CloudSat,

  - ana4MIPs
    - Major reanalyses reformatted to comply with CMIP5 data
      - ECMWF Interim, MERRA, CFSR, JRA25, 20CR
  - New tools for handling data from ESGF

Takmeng Wong (CERES Science team meeting) compared ECMWF-Interim with CERES

ECMWF Interim has lower variability of clear-sky flux than CERES

Parameters (Wm^{-2})	ERA Int. 10y-avg	CERES 10y-avg	Mean Diff. ERA-Ceres	ERA Int 2-σ	CERES 2-σ
Solar Incoming	341.2	339.9	1.3 (0.4%)	0.01	0.20
Longwave	245.5	239.6	5.9 (2.5%)	0.96	0.47
Shortwave	99.3	99.7	-0.4 (-0.4%)	1.26	0.42
Net	-3.6	0.6	-4.2 (-700%)	0.66	0.58
Clear Longwave	264.0	265.6	-1.6 (-0.6%)	0.40	0.67
Clear Shortwave	53.2	52.6	0.6 (1.1%)	0.24	0.31
Clear Net	24.0	21.7	2.3 (10.6%)	0.40	0.68

Global mean comparison – shortened CERES period to accommodate one of the reanalyses (March 2000-June 2012)

	CERES	ECMWF	CFSR	MERRA	JRA-25
$OLR_{all\ sky}$	239.7	245.63	243.5	242.3	254.9
$OLR_{clear\text{-}sky}$	265.75	264.0	266.1	268.1	272.2

Far-IR (400-600 cm^{-1}) difference

From Chen, Huang, Loeb and Wei - (J. Clim.2013)

Points to discrepancy in diurnal cycle of surface temperature in high elevations. Likely due to thermal inhomogeneity in surface.

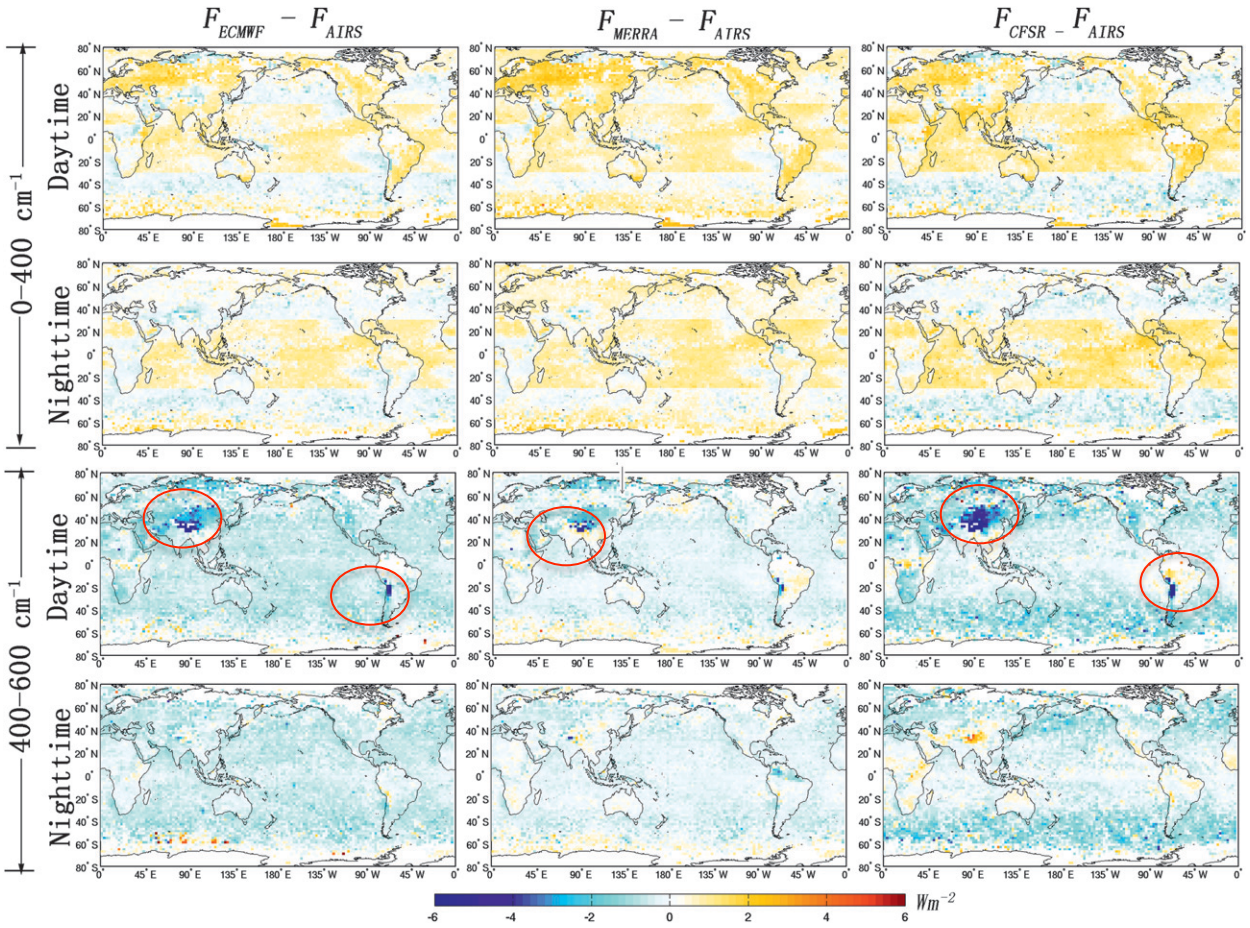


FIG. 9. The spatial maps of annual-mean differences between the far-IR fluxes computed from the reanalyses and those inferred from the collocated AIRS and CERES measurements in 2004. (top to bottom) Daytime and nighttime differences over the 0–400 cm^{-1} band and daytime and nighttime differences over the 400–600 cm^{-1} band. Different columns are for different reanalysis datasets: (left to right) the ERA-Interim, MERRA, and CFSR. Individual differences are averaged onto 2.5° × 2° grids for this plotting.

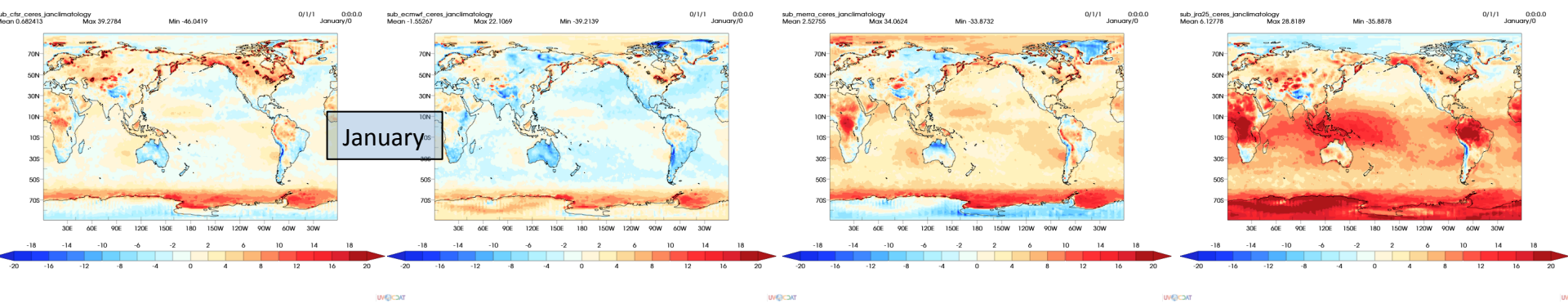
Does this diurnal effect show up in monthly average clear-sky fluxes?

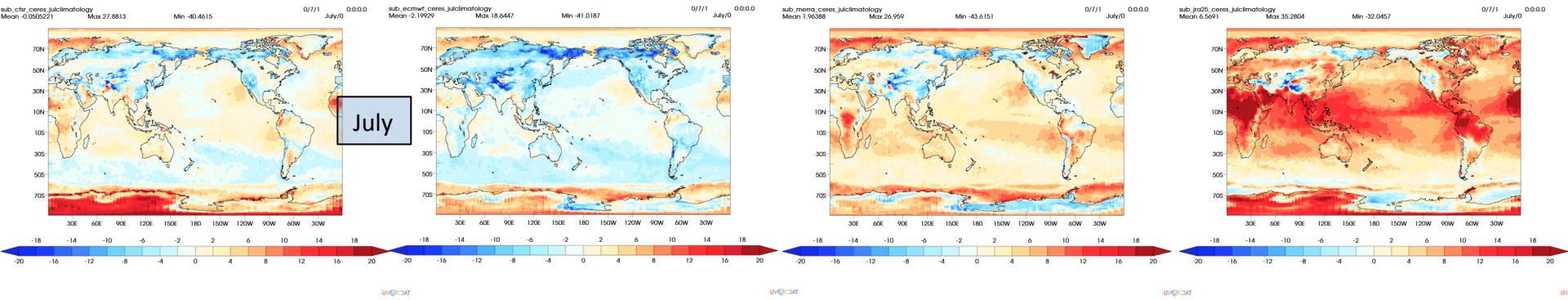
CFSR

ECMWF

MERRA

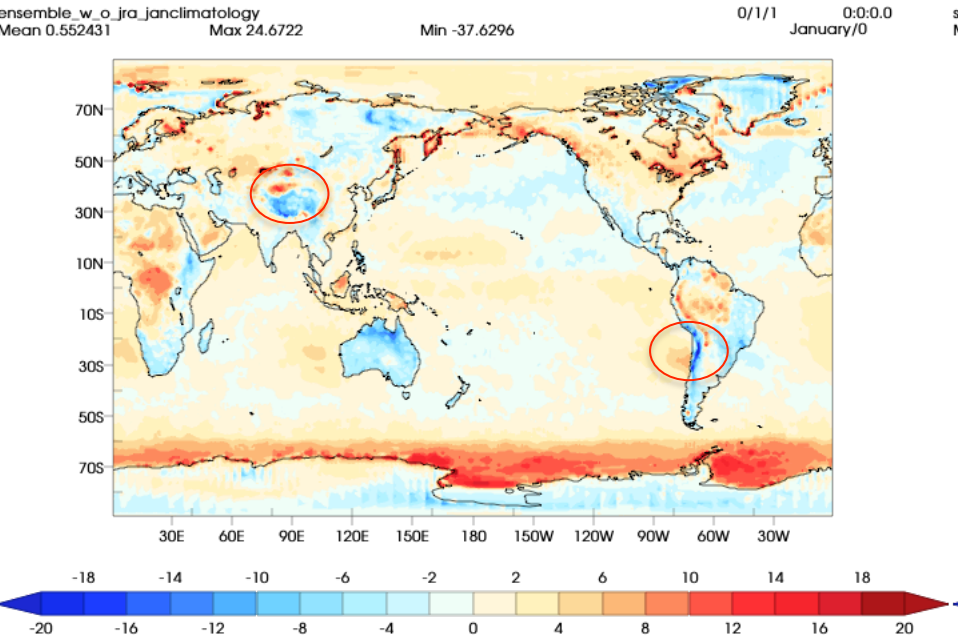
JRA-25



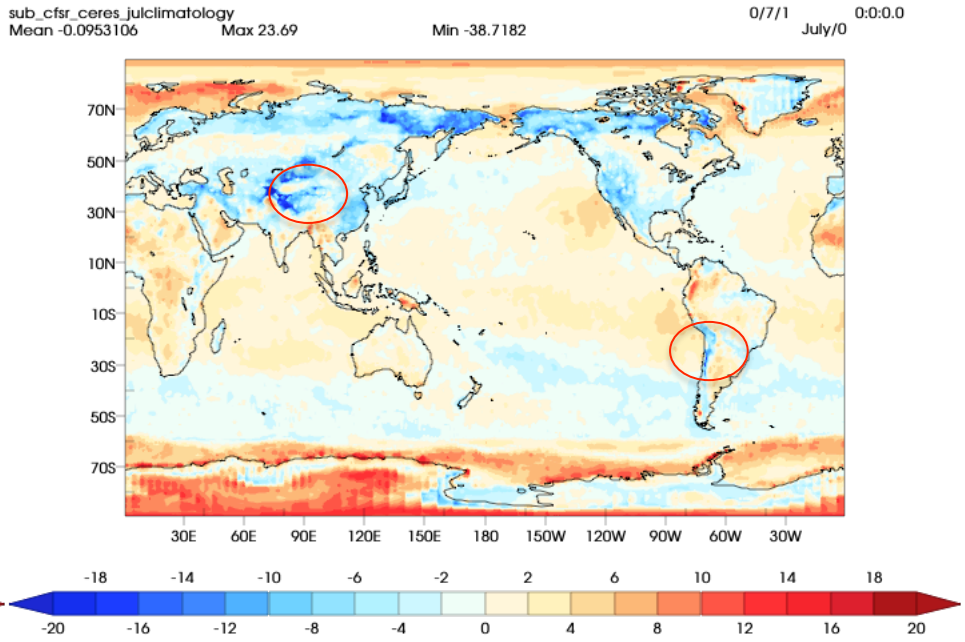


Ensemble average of 3 reanalyses

January



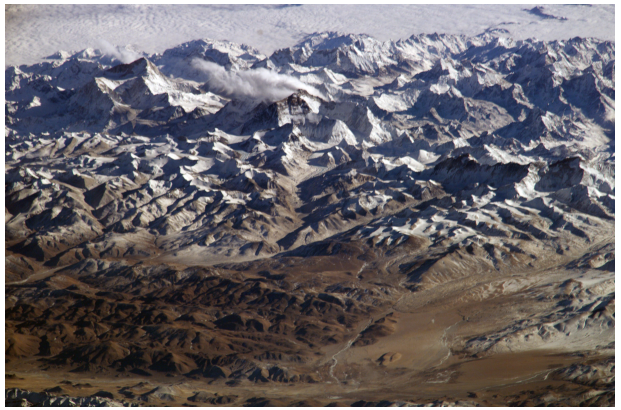
July



This may be the far IR effect but it will be necessary to separate day and night to confirm

Differences between Reanalysis and CERES

- Large difference over high mountains summer day time
- Homogeneous surface in reanalysis
- Day-night difference – can we detect in monthly average?
- Xianglei Huang's work – far IR band



Summary

- Method I and II still relevant
- We can easily use ensemble average of reanalyses – thanks to new project
- Reanalyses can learn something from observations that are not assimilated
  - Diagnosing the LW bands can reveal errors in reanalysis